Deaths from All Causes in Non-Smokers Who Lived with Smokers

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Abstract: Mortality associated with passive smoking was evaluated in a 12-year study of 27,891 White adult smokers and 19,035 never smokers identified in 1963. Death rates were calculated using an estimate of the person-years at risk. Adjusted for age, marital status, education, and quality of housing, the estimated relative risks of death from all causes were 1.17 (approximate 95% confidence interval 1.01, 1.36) for men and 1.15 (1.06, 1.24) for women with passive exposure. These relative risks were similar to those for ex-smokers and for pipe or cigar smokers. Risks increased slightly with level of exposure. The relative risk from passive smoking was greatest for men under age 50 (RR = 2.09, 1.31–3.34). Risks from passive smoking were slightly elevated for several causes among men and women, and may be broader than those previously reported. On the other hand, these small nonspecific increases in death rates may reflect other characteristics of passive smokers that increase mortality. (*Am J Public Health* 1989; 79:163–167.)

Introduction

Smokers are generally reported to have almost doubled age-adjusted death rates.[1] This increased mortality is observed for all causes combined as well as for specific causes, and is not entirely explained by smokers' substantially increased risk for lung cancer or arteriosclerotic heart disease.

Non-smokers who live with smokers are exposed to many of the same potentially toxic consituents of cigarette smoke[2] and they, too, may be at increased risk for death from a variety of causes. These "passive smokers," like active smokers, have increased levels of smoke by-products in body fluids,[3,4] increased activation of enzyme systems that metabolize potential carcinogens,[5] and increased levels of urinary mutagens,[6,7] albeit all at much lower levels than active smokers.

More than a dozen studies have demonstrated increased lung cancer risk among passive smokers,[2] and several studies have suggested increased heart disease risk for passive smokers.[8–11] Studies have also reported increased overall cancer risk,[12–14] with risks not limited to respiratory tract cancers, but the data are limited and findings inconclusive. Only a few reports have concerned total mortality among passive smokers. In the Multiple Risk Factor Intervention Trial, total mortality was increased nearly two-fold among men at risk for heart disease who were married to smokers.[8] A small increase in total mortality was reported for non-smoking women with environmental tobacco smoke exposure in Scotland, but no association was observed for men.[15] Total mortality was slightly increased for passively exposed women in a small US study,[9] but no association between passive smoke exposure and total mortality was found in a study in Amsterdam.[16]

We evaluated mortality from all causes and specific causes in non-smokers living with smokers who had been surveyed in 1963 as part of a private community-wide census in Western Maryland.

Methods

In July 1963 a private census obtained data on an estimated 98 per cent of the households in Washington County, Maryland. The census provided information on sex, age, race, marital status, years of schooling, church attendance, and housing characteristics for 91,909 individuals. Information on cigarette, cigar, and pipe smoking habits was recorded for each household member age 16-½ or older as of July 15, 1963.

To take into account losses from the population resulting from deaths and emigration, a follow-up study of a 5 per cent sample of households that took part in the 1963 census was conducted in 1971. Age, marital status, years of schooling, and frequency of church attendance were associated with remaining in the county after eight years based on a linear model that adjusted for effects of these and other socioeconomic and demographic variables. The addition of sex, smoking status in 1963, and number of bathrooms to the model did not alter the results. The resulting linear model was used to assign to each adult in the 1963 census their probability of still living in the county. From this, an annual probability could be calculated, allowing the population remaining in the county to be estimated at any point in time. The procedure used to estimate the probability of remaining in the county has been described in greater detail by Comstock and Tonascia.[17]

Death certificates of Washington County residents who died between July 1963 and July 1975 were matched against the census and have been coded by one of the authors (GWC) as to primary, contributing, and underlying causes of death according to the seventh revision of the International Classification of Disease (ICD).[18] For this report, deaths were classified in broad groupings using the underlying cause of death.

Data are reported here for adults who were over age 25 in 1963. Because only about 2 per cent of the census population was Black, the analysis is limited to Whites. This report is based on data from a total of 22,973 White men and 25,369 White women.

Study subjects were classified according to their smoking status in 1963. Smoking status was not known for 587 men (2.6 per cent) and 527 women (2.1 per cent). An additional 212 men and 90 women known to be smokers were excluded from this report because the number of cigarettes smoked was not known, leaving 22,174 men and 24,752 women for analysis.

A household smoke exposure score was calculated to serve as a measure of passive smoking. To create this score, each adult was assigned a smoking contribution score ranging from 0 to 12 based on their personal smoking history.[11] A household smoking total was calculated as the sum of the smoking contribution scores of all persons living in that household, and each individual's household smoke exposure

TABLE 1—All Cause Mortality by Smoking Status in 1963

Smoking Status	Men				Women			
	N#	Deaths	Adj RR*	(95% CI)	N#	Deaths	Adj RR*	(95% CI)
Non-smokers	2,914	585	1.00	—	5,322	1,224	1.00	—
Passive smokers	1,248	258	1.17	(1.01, 1.36)	9,551	1,556	1.15	(1.06, 1.24)
Pipe/cigar only	1,671	504	1.20	(1.07, 1.35)	10	2	0.70	(0.18, 2.75)
Ex-smokers	4,562	997	1.16	(1.05, 1.28)	2,153	186	1.03	(0.87, 1.21)
Current smokers	11,779	2,090	1.41	(1.29, 1.55)	7,716	697	1.26	(1.13, 1.40)
<10 cigarettes	1,583	315	1.14	(0.99, 1.31)	2,248	222	1.12	(0.96, 1.30)
10+ cigarettes	10,196	1,775	1.49	(1.35, 1.64)	5,468	475	1.34	(1.19, 1.52)

Number of subjects.
*Adjusted for age, housing quality, schooling, and marital status.

score was the household total minus his or her own contribution to it. The person's own smoking was treated separately in the analysis.

The household exposure score cannot measure total passive smoke exposure because it is not known, for example, how many of the cigarettes smoked per day were smoked outside of the home. Nevertheless, this score is an indicator of the relative degree of exposure in 1963. The group of non-smokers living with non-smokers will have had, on average, the least household exposure to tobacco smoke, while persons living with several heavy smokers will have had, on average, the highest levels of household exposure. Among the 4,162 men and 14,873 women who were reported in 1963 as never smokers, 1,248 men (30.0 per cent) and 9,551 women (64.2 per cent) had household smoke exposure and are considered passive smokers; the remainder are considered non-smokers.

A housing index (ranging from 0 to 10) based on running water, number of bathrooms, type of heating system, cooking fuel, and availability of a telephone was created to serve as a rough indicator of quality of housing and socioeconomic status. For this analysis, housing quality has been classified as poor (index = 0–7) or good (index = 8–10). Education has been categorized as 0–8, 9–11, 12, and 13 or more years of schooling. Subjects were characterized as those married in 1963 and those not. In overall analyses, age has been categorized as 25–44, 45–54, 55–64, and 65+. In analyses restricted to those under age 50, age was categorized as less than 40 and 40–49 in 1963. For persons older than 50, age was categorized as 50–59, 60–69, and 70 or more years.

Average annual death rates were calculated as the number of deaths during the 12 years from 1963 to 1975 divided by the number of person-years of follow-up estimated

from the assigned probability scores for still living in the county. Relative risks were calculated as the average annual death rates among smokers or passive smokers divided by the death rates among nonsmokers without household smoke exposure. Age, marital status, and other factors were strongly related to both death rates and smoking status in this population. Accordingly, all relative risks were adjusted for differences in age, marital status, housing quality, and education using Poisson regression.[19]

Results

The number of deaths and person years of follow-up are shown by smoking status in 1963 and sex in Table 1. After adjusting for age, marital status, education, and housing quality, passive smokers were at increased risk for death from all causes relative to non-smokers. Adjusted relative risks were 1.17 (approximate 95 per cent confidence intervals 1.01, 1.36) for men and 1.15 (1.06, 1.24) for women. These relative risks were similar to those for pipe or cigar smokers, ex-smokers, and smokers of fewer than 10 cigarettes a day, and were less than half that observed for heavier active smokers.

Among men, the relative risk for passive smokers under age 50 was 2.09 (1.31, 3.34), and the relative risk for heavier active smokers was 3.16 (2.27, 4.41) (Table 2). Among those age 50 and older, the corresponding relative risks were substantially less. The difference between the death rates for passive smokers and non-smokers was similar, however, in both age groups (2.6/1,000 for those younger than age 50 and 2.3 for those 50 and older). Among women, while the relative risk for active smoking was greater for those younger than 50 in 1963, the relative risk for passive smoking did not vary with age. Among passive smokers there was some increase in

TABLE 2—All Cause Mortality by Smoking Status and Age in 1963

Smoking Status	Men				Women			
	Age <50		Age 50+		Age <50		Age 50+	
	Adj RR*	(95% CI)	Adj RR	(95% CI)	Adj RR	(95% CI)	Adj RR	(95% CI)
Non-smokers	1.00	—	1.00	—	1.00	—	1.00	—
Passive smokers	2.09	(1.31, 3.34)	1.11	(0.95, 1.30)	1.14	(0.81, 1.62)	1.14	(1.05, 1.23)
Pipe/cigar only	1.83	(1.13, 2.96)	1.13	(1.00, 1.28)	—	—	0.72	(0.18, 2.86)
Ex-smokers	1.94	(1.34, 2.81)	1.15	(1.03, 1.28)	1.57	(1.05, 2.36)	1.00	(0.83, 1.20)
Current smokers	3.06	(2.20, 4.27)	1.33	(1.20, 1.47)	1.79	(1.30, 2.47)	1.27	(1.13, 1.43)
<10 cigarettes	2.28	(1.49, 3.48)	1.12	(0.97, 1.30)	1.34	(0.88, 2.02)	1.18	(1.00, 1.39)
10+ cigarettes	3.16	(2.27, 4.41)	1.39	(1.26, 1.55)	1.96	(1.42, 2.71)	1.33	(1.16, 1.53)

*Adjusted for age, housing quality, schooling, and marital status.

TABLE 3—All Cause Mortality among Never Smokers by Degree of Passive Smoke Exposure and Age

	Age <50			Age 50+			Total		
Exposure Score	Deaths	Adj RR*	(95% CI)	Deaths	Adj RR	(95% CI)	Deaths	Adj RR	(95% CI)
Men									
0 (none)	37	1.00	—	548	1.00	—	585	1.00	—
1+ (any)	35	2.09	(1.31, 3.34)	223	1.11	(0.95, 1.30)	258	1.17	(1.01, 1.36)
1–5 (light)	12	1.59	(0.83, 3.07)	95	1.11	(0.89, 1.38)	107	1.13	(0.92, 1.39)
6+ (heavy)	23	2.50	(1.48, 4.24)	128	1.11	(0.91, 1.35)	151	1.20	(1.00, 1.44)
Women									
0	47	1.00	—	1,177	1.00	—	1,224	1.00	—
1+	132	1.14	(0.81, 1.62)	1,424	1.14	(1.05, 1.23)	1,556	1.15	(1.06, 1.24)
1–5	53	1.24	(0.83, 1.86)	650	1.09	(0.98, 1.21)	703	1.12	(1.02, 1.24)
6+	79	1.08	(0.75, 1.58)	774	1.17	(1.06, 1.28)	853	1.16	(1.06, 1.27)

*Adjusted for age, housing quality, schooling, and marital status.

overall relative risk for death from all causes with increasing household exposure to smoke, but no clear trends (Table 3).

Passive smoking-associated adjusted relative risks for individual causes of death are shown for never smoking men and women in Table 4. The relative risks for male and female passive smokers were greater than one for several smoking related and other causes, although risk estimates were stable only for arteriosclerotic heart disease in men and for arteriosclerotic heart disease, cerebrovascular disease, and chronic lung disease in women.

There were few deaths among men younger than 50 in 1963, but the relative risks for several causes of death, including arteriosclerotic heart disease and cancer, were greater than 2.00 (data not shown).

The increased relative risk for chronic lung disease among women with smoke exposure was limited to women over age 50 in 1963; there were no deaths in this category among younger women. The risk for cerebrovascular disease did not differ by age, but cancer risk was increased only among women younger than age 50. All 12 "smoking-related" cancers (two lung, five cervix, one kidney, three pancreas) among never smoking women younger than 50 were in those with passive smoke exposure.

Among the never smokers, 44 per cent of the deaths among men and 35 per cent of the deaths among women were attributed to arteriosclerotic heart disease. After excluding these deaths, there continued to be an increase in overall mortality for women with passive smoke exposure (Table 5). For men, mortality from causes other than arteriosclerotic heart disease was increased only among passive smokers younger than age 50 [RR = 1.93 (1.09, 3.41)].

Discussion

The finding of increased overall mortality for non-smokers who lived with smokers may not reflect a causal relationship. Much of the increased risk we observed could be attributed to arteriosclerotic heart disease for which an extensive literature documents an increased risk associated with active cigarette smoking.[20] Our own study[11] and others have demonstrated increased risk for heart disease in passive smokers. Svendsen, et al,[8] reported non-smoking men married to smokers were at increased risk for heart disease death [RR = 2.11 (0.69, 6.46)] and risk increased with amount smoked by the spouse. Hirayama[10] reported a 20 per cent increase in mortality from ischemic heart disease among non-smoking women married to smokers. Heart disease

TABLE 4—Deaths from all Causes and Specific Causes among Never Smoking Men and Women

	Men				Women			
	Deaths				Deaths			
Cause of Death	Passive Smokers (12,238 PY)	Non-smokers (29,214 PY)	Adj RR*	(95% CI)	Passive Smokers (97,032 PY)	Non-smokers (51,113 PY)	Adj RR	(95% CI)
All causes	258	585	1.17	(1.01, 1.36)	1,556	1,224	1.15	(1.06, 1.24)
Cancer	31	84	1.01	(0.66, 1.53)	290	211	1.00	(0.82, 1.21)
Smoking related	8	24	0.96	(0.43, 2.16)	49	27	1.45	(0.88, 2.40)
Other	23	60	1.03	(0.40, 2.62)	241	184	0.93	(0.76, 1.54)
Cerebrovascular disease	33	93	0.97	(0.65, 1.46)	297	232	1.24	(1.03, 1.49)
Circulatory diseases	137	304	1.19	(0.97, 1.46)	715	576	1.17	(1.05, 1.32)
Arteriosclerotic heart disease	122	248	1.31	(1.05, 1.64)	551	437	1.19	(1.04, 1.36)
Other	15	56	0.65	(0.36, 1.16)	164	139	1.14	(0.89, 1.29)
Respiratory diseases	15	27	1.44	(0.75, 2.75)	79	72	1.21	(0.87, 1.69)
Emphysema/Bronchitis	2	4	0.93	(0.16, 5.32)	11	2	5.65	(1.19, 26.8)
Other	13	23	1.53	(0.76, 3.07)	68	70	1.08	(0.76, 1.54)
Digestive diseases	9	18	1.34	(0.59, 3.04)	57	39	1.20	(0.78, 1.85)
Genitourinary diseases	3	12	0.67	(0.36, 1.28)	21	11	1.50	(0.69, 3.26)
Accidental causes	15	24	1.48	(0.78, 2.84)	48	35	1.24	(0.78, 1.30)
Other	15	23	1.70	(0.88, 3.29)	49	48	0.76	(0.50, 1.17)

*Adjusted for age, housing quality, schooling, and marital status.

TABLE 5—Mortality among Never Smokers from Arteriosclerotic Heart Disease and Other Causes

Cause of Death	Men		Women	
	Adj RR*	(95% CI)	Adj RR	(95% CI)
Arteriosclerotic heart disease	1.31	(1.05, 1.64)	1.19	(1.04, 1.36)
Other causes	1.06	(0.87, 1.31)	1.12	(1.02, 1.24)

*Adjusted for age, housing quality, schooling, and marital status.

mortality associated with passive smoking was also increased in studies reported by Gillis, et al,[15] and by Garland, et al,[9] but risk estimates were based on small numbers. A study reported by Lee, et al,[21] indicated no heart disease risk from passive smoking.

In our study, an increased relative risk for death remained even after subtracting deaths from arteriosclerotic heart disease. The effect was strongest for women and for younger men. The general increase in mortality leaves open the possibility that the life styles of people who live with smokers differ from those who do not live with smokers. Factors such as alcohol consumption or dietary habits which are correlated with both smoking and risk for some diseases (and which were not collected in the 1963 census) seem especially likely to be alternative explanations for our findings, to the extent that diets or alcohol use are similar among household members.

Studies of passive smokers in general and of passive smokers with heart disease have also examined some of these potential confounding factors with mixed results. In 1963, more than 60 per cent of never smoking women in Washington County lived with smokers,* but it was much less common for non-smoking men to live with smokers. Differences between these men and other men might explain their slight increase in overall mortality. Never smokers who lived with smokers had fewer years of schooling and lived in housing of poorer quality. We adjusted for these differences in our analysis, but residual confounding might still affect our results.

Others have found few differences between those with and without passive smoke exposure that could account for mortality differences between groups. Garland, et al,[9] found no difference in blood pressure, obesity, or cholesterol between women married to smokers and those married to never smokers. Svendsen, et al,[8] found no differences in blood pressure, cholesterol, or psychosocial factors between men married to smokers and men married to non-smokers. They did, however, find that men married to smokers were slightly heavier and drank alcoholic beverages slightly more often than those married to non-smokers. Similarly, Friedman, et al,[22] reported that alcohol consumption and other risk-taking behaviors were more frequent among non-smokers with passive smoke exposure.

Besides heart disease, several other causes of death for which we observed increased death rates for passive smokers are causes that are known or suspected to be caused in part by cigarette smoke. These include respiratory diseases such as emphysema and bronchitis[23] and cerebrovascular disease.[24,25]

Kalandidi, et al,[26] recently reported in a case-control

study that non-smoking women married to current smokers had nearly twice the risk of lung disease as did non-smoking women married to never smokers. Increased chronic lung disease mortality was also reported by Hirayama[27] for Japanese women married to smokers (RR = 1.4), but results in the study by Lee, et al,[21] were inconclusive. Two studies also included data on risk of cerebrovascular disease. Based on very small numbers, stroke risk was increased for women with environmental tobacco smoke exposure in the study by Gillis, et al.[15] In the study by Lee, et al,[21] stroke mortality was increased approximately two-fold for both men and women with high total passive smoke exposure, although not in relation to spouse smoking alone.

While lifestyle or selection factors are a possible explanation for the small increase in overall mortality we observed, it is also possible that continued exposure to cigarette smoke leads to poorer health in general. Smokers have more respiratory illnesses and decreased lung function relative to non-smokers.[24] They may also have altered immune system responses and other changes which indirectly affect disease risk and response.[1] It is possible that passive smoke exposure indirectly increases overall mortality by altering general health status and increasing case-fatality from other illnesses. Increased respiratory symptoms and decreased lung function have been observed for passively exposed children and adults,[2] although not all studies have been positive.[28]

Finally, with relative risks as low as those observed here, and with such a weak dose-response, one must consider that other biases are responsible for these findings. The confidence intervals for the risk estimates shown do not take into account the variability associated with the estimated person years at risk. These estimates were derived from fitting a linear model to follow-up data obtained for a 5 per cent sample of the population. The true person-years of follow up may be larger or smaller than that calculated. Therefore the reported confidence intervals may be slightly too small.

Misclassification of smoking status is also possible. Smoking status was obtained once in 1963 as part of a general community census. Some persons classified as non-smokers may have taken up smoking in the years between 1963 and 1975, and non-smokers who lived with smokers may be more apt to become smokers. Similarly, non-smokers with no smoke exposure may have become exposed as other family members began to smoke or as household composition changed. However, it is more likely that active smokers became ex-smokers over the 12-year period, reducing the overall level of household smoke exposure at which these effects were observed. Thus the dose-specific effects may even be underestimated. Furthermore, individuals who were not exposed at home may have had smoke exposure at work, making it difficult to detect smoking-related health differences between groups.

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NIDA Announces Availability of Videotapes on Drugs in the Workplace

The National Institute on Drug Abuse, the federal agency which serves as the focal point for research and demonstration programs on drug abuse, has announced availability of *Drugs at Work* and *Getting Help*—the first two in a four-part videotape series on drug abuse in the workplace. The videotapes are available either on free loan or for purchase.

- *Drugs At Work*, a 23-minute educational documentary, describes costs of drug use for the workplace, the individual, and the public, and examines action being taken by government and private companies. An important program for all levels in the workplace, from top management to line staff, *Drugs at Work* provides information for developing effective drug abuse workplace programs through policy development, drug testing, employee assistance programs, prevention, and education. Interviews are included with drug users who have sought treatment and with experts on drugs in the workplace. Government and industry representatives describe current federal and corporate programs.

- *Getting Help* presents detailed information about the use of Employee Assistance Programs (EAPs) in addressing drug use in the workplace. The film features comments by business, labor, and government leaders, and EAP professionals; presentation of three model programs; and EAP client interviews. It encourages employers to consider EAPs as a tool in combatting drugs at work, and provides employees with reassuring information about the confidentiality and effectiveness of an EAP program.

The third in the series, *Drug Testing*, and the fourth, *Drug Prevention and Employee Education*, will be available in the near future.

The videotapes—available in both employer and employee versions—are designed to be part of a comprehensive workplace drug abuse program. To arrange a free loan, contact: Modern Talking Picture Service Scheduling Center, 5000 Park Street, North, St. Petersburg, FL 33709, (813) 541-5763. To purchase, contact: National Audio Visual Center, Customer Service Section, 8700 Edgeworth Drive, Capital Heights, MD 20743-3701, (301) 763-1896.